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NEC CORP *J0 1136-973-A
24.11.87-JP-295487 (30.05.89) C23c-16/48 H01l-21/20

Film forming method - comprises applying laser-beam to substrate applying material gases, injecting electric insulation film-forming gas, etc.

C89-087766

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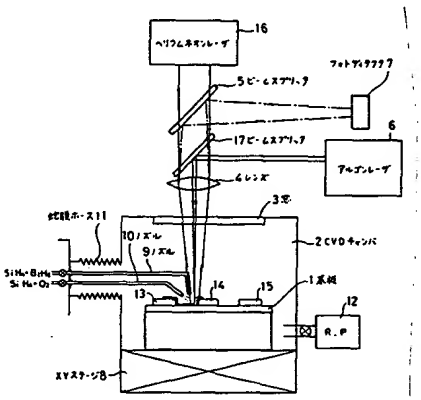

Laser beams from their generators are collected on to the substrate surface, material gases from nozzles are applied by a scanning motion to attain a linear pattern deposition on the substrate, and in the first few deposition cycles, electric insulation film forming gas, e.g. SiH4+02, is injected onto the objective area of the substrate, then an electroconductive film forming gas such as SiH4+ B2H6 is injected.

ADVANTAGE - Using a simple process and appts., objective correction is performed for a mis-patterned integrated circuit. (4ppDwg.No. 1/1)

427/583

⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　平1－136973

⑤1Int.Cl.⁴	識別記号	庁内整理番号	⑬公開　平成1年(1989)5月30日
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21/88		B－6708－5F	審査請求　未請求　発明の数 1　(全4頁)

⑤4発明の名称　成膜方法

⑳特　願　昭62－295487

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明　細　書

1.発明の名称

成膜方法

2.特許請求の範囲

レーザ光を基板に集光させ、その基板上における前記レーザ光の集光点に原料ガスを吹き付けると共に、前記基板を前記集光点に対して走査することによって線状の成膜を行う直描成膜方法において、絶縁すべき配線上では2回以上のビーム走査を繰り返し、そのビーム走査のうちの始めの1回目または数回の走査では絶縁膜形成用のガスを吹き付けて、その後の走査では導電性膜形成用のガスを吹き付けてレーザCVD直描を行うことを特徴とする成膜方法。

3.発明の詳細な説明

(産業上の利用分野)

本発明は、半導体集積回路の試作品における誤配線の修正などに用いて好適な成膜方法に関する。

(従来技術と発明が解決しようとする問題点)

集積回路製造の試作段階で発生する誤配線を修正する技術としてレーザCVDによるオンチップの直描レーザCVDが利用されつつある。この技術は、修正を要する未結線部のあるチップをCVD原料ガス雰囲気に入れ、レーザ光を結線すべき配線の1部に照射して原料ガスを基板加熱による熱分解、もしくは光化学分解により分解して金属膜を堆積させながら基板を移動させて結線すべき配線まで金属線を描画するものである。このような配線修正の方法としては、結線すべき配線を覆う保護膜に穴をあけ、その後、直描レーザCVDで結線する方法が第34回応用物理学会関係連合講演会の講演予稿集484ページ(1987)に発表されている。しかし、結線すべき配線の間にこれらの配線とは絶縁すべき配線が存在するような修正の場合には、その配線のみを絶縁するための処置が直描レーザCVDとは別に必要になる。

このような配線修正の方法としては、はじめに配線全体を覆う絶縁膜を基板全体に形成した後、結線すべき配線の上部の絶縁膜に穴をあけて結線することが考えられる。しかしこの方法では直描レーザＣＶＤの他に絶縁膜形成工程、穴開け工程が必要となるから工数は多くなる。これよりも工数を簡略化する方法としては、絶縁すべき配線と修正用の配線とが重なる面積だけにパターン転写レーザＣＶＤにより絶縁膜の局所選択ＣＶＤを施し、その後金属の直描レーザＣＶＤにより結線を行う方法が第31回半導体・集積回路技術シンポジウム講演論文集85ページ（1986）に提案されている。この技術では穴開け工程がない分だけ工程は短縮されるが、転写では成膜速度が直描に比べて低いから、絶縁所望箇所で基板を長い時間停止しなくてはならず、直描だけの場合に比べて時間がかかる。また光学系も直描と転写の２種類が必要であり、光学系が複雑かつ高価となり、光学系用に広いスペースを必要とする。本発明の目的は、このような従来技術の問題点を解決し、工程が簡単で、小形で簡単な装置を用いて局所絶縁も含めた配線修正が短時間に行える方法の提供にある。

（問題点を解決するための手段）

本発明は上記の従来技術の問題点を解決するために、レーザ光を基板に集光させ、その基板上における前記レーザ光の集光点に原料ガスを吹き付けると共に、前記基板を前記集光点に対して走査することによって線状の成膜を行う直描成膜方法において、絶縁すべき配線上では２回以上のビーム走査を繰り返し、そのビーム走査のうちの始めの１回目または数回の走査では絶縁膜形成用のガスを吹き付けて、その後の走査では導電性膜形成用のガスを吹き付けてレーザＣＶＤ直描を行うという手段をとった。

（作用）

原料ガス雰囲気でレーザを基板に集光照射して、原料ガスを基板加熱により熱分解、あるいは光化学分解しながらレーザ光、或は基板を走査する直描ＣＶＤ技術において、走査を止めることなく原料ガスのみを同じレーザ光で熱分解、或は光化学分解する別の原料ガスに入れ換えれば、異種の物質からなる線で連続したパターンを描画することができる。本発明は、このことを利用して、結線すべき配線と配線の間にこれらとは絶縁すべき配線があるような誤配線を直描レーザＣＶＤにより修正する場合、絶縁すべき配線にレーザ光がさしかかると同時に原料ガスを金属膜用原料ガスから絶縁膜用原料ガスに切り替えて、絶縁すべき配線上に絶縁膜を描画し、その後、絶縁膜用原料ガスに切り替えた点までレーザ集光点をもどして、再び原料ガスを金属膜用原料ガスに替えて金属線の直描ＣＶＤを、既に直描した絶縁膜の上を通って結線すべき配線まで行うことによって、所望の配線のみの結線を行うものである。本発明においては直描の前工程として絶縁膜を全面形成することも局所選択形成することも必要でなく、そのための工程がかからない。また穴開けの工程も必要ない。また光学系も１つでよいので装置のスペースが少なくてすむ。

（実施例）

以下、本発明を、結線すべき２つの配線とこれらの間にあってこれらとは絶縁すべき１つの配線とが同一の絶縁膜上に存在する集積回路をレーザによる直描ＣＶＤによって修正する工程に本発明を適用した実施例を図面を参照して詳細に行う。

第１図は、本発明を適用した配線修正を行う装置の模式図である。基板１はＣＶＤチャンバ２内に固定し、アルゴンレーザ６からの出射光をビームスプリッタ５，ビームスプリッタ17，レンズ４，窓３を通して基板１上に垂直に集光照射する。アルゴンレーザ６よりビーム径の大きいヘリウムネオンレーザ16の光軸をアルゴンレーザ６の光軸に合わせてビームスプリッタ17によって基板１に照射し、基板１からのヘリウムネオンレーザ16の反射光は、ビームスプリッタ５により入射光と分離して、フォトディテクタ７によってその強度をモニタする。ＣＶＤチャンバ２はＸＹステージ８の上に固定しＸＹ方向にステージを動かすことによって、アルゴンレーザ６の集光点を所望の箇所に走査させることが出来る。金属膜形成用の

原料ガスとしてはジボランとシランの混合ガスを用い、金属膜形成用原料ガス吹き出しのノズル9からこれを基板1上のレーザ光の集光点に向かって吹き付ける。また絶縁膜形成用原料ガスとしては酸素とシランの混合ガスを用い絶縁膜形成用原料ガス吹き出し用のノズル10からやはり基板1のレーザ光の集光点にむかって吹き付ける。各ガスのエアバルブの開閉で、原料ガスを適宜、速やかに交換して基板1に吹き付けることが可能である。またこれらのノズル9，ノズル10とＣＶＤチャンバ2とはフレキシブルなテフロン製の蛇腹ホース11で連結しているので、ＣＶＤチャンバ2がＸＹステージ8によって移動させられても、ノズル9，10はＣＶＤチャンバ2と一緒に移動することはなく、ガスの吹き出す方向は常にレーザ光の集光点に向かっている。ＣＶＤチャンバ2内の排気はロータリーポンプ12によって行う。

配線修正を実際に行う手順を以下に述べる。ノズル9からジボランとシランの混合ガスを基板1に吹き付けて配線13上にレーザ光を集光しこれらの原料ガスをレーザ光照射による基板加熱の効果で分解しボロンドープシリコンを形成する。ヘリウムネオンレーザ16の反射光をフォトディテクタ7でモニタしながらレーザ集光点が配線14に向かうようにＸＹステージ8で基板1を動かしてボロンドープシリコン膜の直描を行う。集光点が配線14にさしかかると反射光の強度が急激に上がるので、この位置からは原料ガスを酸素とシランの混合ガスにかえてノズル10から基板1上に吹き付ける。引き続いて反射光をモニタしながら、やはり基板加熱効果を利用してシリコン酸化膜の直描を行い、反射光の強度が配線14にさしかかる前の強度にまで下がった時点でステージをこれまでと逆の方向、すなわち配線13が集光点に向かう方向に移動させ、集光点が既に直描されたボロンドープシリコンにさしかかって反射光の強度が再び上がった時点で、原料ガスをジボランとシランの混合ガスに替え、配線15までボロンドープシリコンの直描を行い配線14を絶縁した状態で配線13と配線15とを結線する。

本発明においては、適宜原料ガスを切り替えてレーザＣＶＤの直描配線の工程だけで必要箇所を絶縁しながら配線を修正できるので、全面、或は局所に絶縁膜を形成したり、また絶縁膜に穴開けを施したりする工程を経ることなく、わずか1工程で配線修正ができた。

なお本発明においては原料ガスの切り替えに要する時間は0.1秒以下で、この間にステージが移動する距離は集光径に対して十分小さいので断線は生じなかった。また、原料ガスの切り替えの際に2つのガスが若干混ざり合うが堆積に必要な原料ガスは集光点に吹き付けて供給するので、他方の原料ガスのよどみの影響はデバイスの電気特性に支障をきたさない程度であった。

本発明の実施例ではレーザ光照射による基板加熱の効果で原料ガスを分解して成膜する場合についてのみ述べたが、必ずしも熱的な分解である必要はなく、原料ガスとして、金属用にジシランとボロンの混合ガス、絶縁膜用にジシランと酸素を用い、光源としてArFレーザ（193nm）を用いれば、光化学分解を利用した配線修正も可能である。

また本実施例では結線すべき配線と配線の間に絶縁すべき配線が一本しかない場合についてのみ説明したが、絶縁すべき配線が2本以上ある場合でも全く同様の修正が可能である。

（発明の効果）

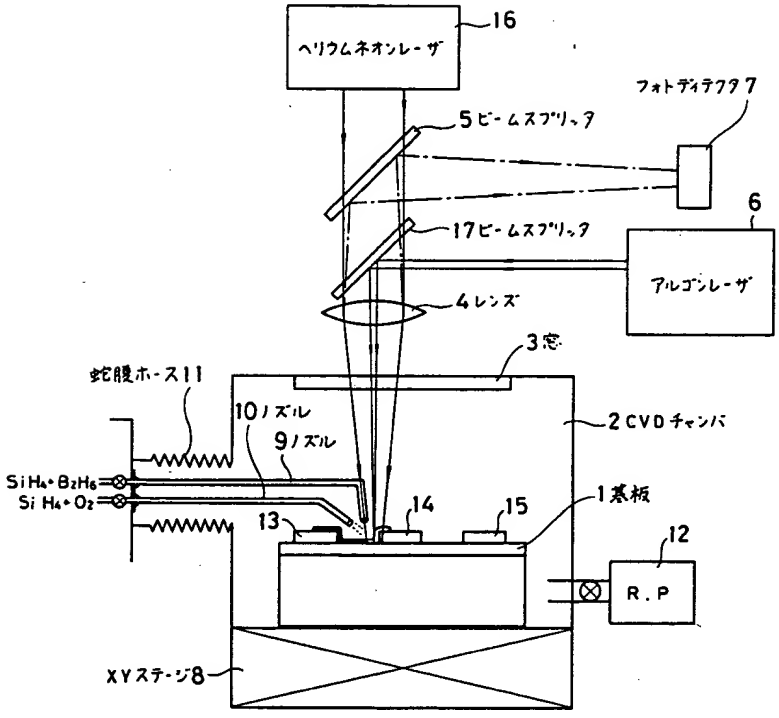
以上に説明したように、本発明の方法によれば、レーザによる直描ＣＶＤの際に原料ガスを替えることによって必要箇所を絶縁できるから、他の工程を設けることなく直描ＣＶＤだけで配線を修正できる。また必要な光学系は1種類だけなので、装置も小形化できる。このように、本発明によれば、小形で簡単な装置を用いて局所絶縁も含めた配線修正が簡単な工程で短時間に行える成膜方法を提供できる。

4.図面の簡単な説明

第1図は、本発明の一実施例の方法を適用した装置を示す模式図である。

1…基板、2…ＣＶＤチャンバ、3…窓、4…レンズ、5，17…ビームスプリッタ、6…アルゴンレーザ、7…フォトディテクタ、8…ＸＹステージ、9，10…ノズル、11…蛇腹ホース、12…ロータリーポンプ、13，14，15…配線、16…ヘリウムネオンレーザ。

代理人　弁理士　本庄伸介



第１図

Sup doc. cited PTO-892 10/3/97 (9/15/94)

NEC. Corp.

Japanese Patent (Laid-Open) Publication No. HEI-1-136973

Publication Date: May 30, 1989

Application No. SHO-62-295487

Application Date: November 24, 1987

Title of the Invention: METHOD OF FORMING FILM

Int. Cl.4 C23C 16/48, H01L 21/205, 21/88

Inventors: Yuko Okeura and Yukio Morishige

staff of Nippon Electric Corporation

Applicant: NEC

Agent: Shinsuke Honjo, Patent Attorney

SPECIFICATION

1. Title of the Invention: METHOD OF FORMING FILM

2. CLAIM

A method of forming film based on direct-draw film forming method comprising;

a step of causing laser beams to be condensed onto a substrate;

a step of causing raw-material gas to be blown onto condensing point of said laser beams; and

a step of executing linear formation of film by causing said substrate to be scanned against said condensing point;

said method further comprises a step of repeating beam-scan for two rounds or more than two rounds on such wiring to be subject to insulation; a step of blowing insulation-

film-forming gas in the first-round scan or for several rounds of said scanning process; and a step of executing laser CVD direct-drawing by way of blowing gas usable for forming electrically conductive film in the scanning process thereafter.

3. DETAILED DESCRIPTION OF THE INVENTION

(Field of Industrial Utility)

The present invention relates to a method of forming film suited for correcting erroneous wiring in trial production of semiconductor integrated circuit.

(Prior art and problem to be solved by the Invention)

As an art of correcting erroneous wiring generated in trial production of semiconductor integrated circuit, on-chip direct-draw laser CVD via laser CVD has been utilized. This method comprises a step of placing such a chip having not-yet-wired-portion requiring correction in atmosphere containing CVD raw-material gas and a step of irradiating laser beams onto part of wiring to be connected to cause raw-material gas to be decomposed by way of pyrolysis or via photochemical decomposition, a step of shifting substrate while causing metallic film to be deposited, and a step of drawing metallic line up to wiring to be connected. As a method of correcting wiring, such an art was announced on page 484 of preliminary lecture draft (1987) presented for the 34th joint lecture

meeting associated with academy of applied physics, which proposed a method to initially provide holes in protection film covering wiring to be connected and then connect wiring via direct-draw laser CVD. However, in the case of making correction to enable presence of wiring to be insulated between wires to be connected, independently of the direct-draw laser CVD, a process for solely insulating said wire is required. As the method for correcting the wiring, such a means is conceived, which initially causes insulation film covering all the wiring to be formed all over the substrate, and then forms holes in the insulation film above the wiring to be connected. However, according to this method, aside from the direct-draw laser CVD, a process for forming insulation film and another process for forming holes are required to result in the increased number of processing steps. As a means for simplifying the processing steps, such an art was proposed on page 85 of the lecture paper summary (1986) presented for the 31st symposium on semiconductor/integrated circuit technology, which proposed such an art which initially applies locally selected CVD onto insulation film via pattern-transcribing laser CVD solely against such area on which wiring to be insulated and wiring for correction are superposed and then executes wiring via metal-directly-drawing laser CVD. According to this method, process is contracted by such a scope that deletes a process for forming holes. However, inasmuch

as film forming speed via the transcription is lower than the case of the direct-drawing, substrate is obliged to remain in halt at the portion at which insulation is desired, and thus, a longer time is necessary than in the case of solely effecting direct-drawing. Further, the above art requires two kinds of optical system used for the direct-drawing and the transcription, and yet, the optical systems become more complex and expensive. Further, broad space is required for the optical systems. The object of the invention is to solve the above-referred problem related to conventional arts by providing such a method enabling correction of wiring including local insulation to be executed in a short period of time via simple process and by applying a compact and simplified apparatus.

(Means for solving problem)

In order to solve the above problems related to conventional arts, the invention has introduced such a method of forming film based on direct-draw film forming method comprising; a step of causing laser beams to be condensed onto a substrate, a step of causing raw-material gas to be blown onto condensing point of said laser beam, and a step of executing linear formation of film by causing said substrate to be scanned against said condensing point, where the above method further comprises a step of repeating beam-scan for two rounds or more than two rounds on the wiring to be insulated,

a step of blowing insulation-film-forming gas in the first-round scan or for several rounds of said scanning process, and a step of executing laser CVD direct-drawing by way of blowing gas usable for forming electrically conductive film in the scanning process thereafter.

(Operation)

In the direct-drawing CVD art which initially condenses and irradiates laser beams onto substrate in atmosphere containing raw-material gas and then scans laser beams or the substrate by causing raw-material gas to be decomposed via pyrolysis caused by heating of the substrate or via photochemical decomposition, by way of solely replacing raw-material gas with another raw-material gas subject to pyrolysis or photochemical decomposition via identical laser beams without suspending scan, it is possible to draw continuous pattern via line made from material of a different kind. Availing of this, the invention executes connection of only the desired wiring by implementing the following: Concretely, in the case of correcting erroneous wiring via direct-drawing laser CVD in such a case in which such a wiring requiring insulation is present between those wires to be connected to each other, simultaneous with irradiation of laser beams onto the wiring to be insulated, raw-material gas usable for forming metallic film is replaced by raw-material gas usable for forming insulation film. Then, laser-beam

condensing point is drawn back to the point at which the raw-material gas usable for insulation film replaced the former raw-material gas, and then, the insulation-film-forming-raw-material-gas is replaced by the metal-film-forming raw-material gas to execute metallic-line direct-drawing CVD process up to the wiring to be connected by way of passing over the directly drawn insulation film, thus achieving connection of only the desired wiring. In the invention, it is not necessary to form insulation film all over the surface or locally and selectively form said film as the preliminary process of the direct drawing, and thus, process otherwise needed for said preliminary process can be deleted. Further, process for forming holes is not required. Further, since only one unit of optical system is needed, space needed for installation can be saved.

(Embodiments)

Referring now to the accompanying drawing, an embodiment applying the invention is described in detail below. The invention has been applied to such a process for correcting an integrated circuit incorporating a pair of wiring lines to be connected and a single wiring provided between said wiring lines to be insulated from said single line respectively being present on an identical insulation film by means of the laser-beam-applied directly drawing CVD method.

FIG. 1 is a schematic block diagram of an apparatus for

executing correction of wiring by applying the invention. Substrate 1 is secured inside of a CVD chamber 2. Beams emitted from an argon laser 6 are vertically condensed via beam splitter 5, another beam splitter 17, a lens 4, and a window 3, and then irradiated onto the substrate 1. Light axis of helium-neon laser 16 having such a beam diameter being greater than that of the argon laser 6 is irradiated onto the substrate 1 via the beam splitter 17 in coincidence with light axis of the argon laser 6. Beams of the helium-neon laser 16 reflected by the substrate 1 are split from incident beams by the beam splitter 5, and then, intensity of the reflected beams is monitored by photo-detector 7. The CVD chamber 2 is secured on X-Y stage 8. By shifting the stage in the X-Y direction, it is possible to scan the condensing point of the argon laser 6 to desired location. As the raw-material gas for the formation of metallic film, mixed gas composed of diborane and silane is used. The mixed gas is blown onto condensing point of laser beams on the substrate 1 via nozzle 9 used for blowing metallic-film forming raw-material gas.

As the raw-material gas for the formation of insulation film, mixed gas composed of oxygen and silane is used. The mixed gas is blown onto condensing point of laser beams on the substrate 1 via nozzle 10 used for blowing insulation-film-forming raw-material gas. It is possible to blow raw-material gas onto the substrate 1 by properly and swiftly

exchanging raw-material gas by opening and closing operation of air valves for treating respective gas. The nozzle 9, nozzle 10, and the CVD chamber 2 are linked with each other via bellow-hoses 11 made from flexible "TEFLON", and thus, even when the CVD chamber 2 has been shifted by the X-Y stage 8, the nozzles 9 and 10 are not moveable in conjunction with the CVD chamber 2, thus enabling the gas-blowing direction to be constantly oriented to the condensing point of laser beams. Discharge of exhaust inside of the CVD chamber 2 is executed by a rotary pump 12.

Next, sequence for actually executing the correction of wiring is described below. Mixed gas composed of diborane and silane is blown onto the substrate 1 via the nozzle 9 to cause laser beams to be condensed onto wiring 13. By causing said raw-material gas to be decomposed by effect of heating the substrate via laser-beam irradiation, and then, boron-doped silicon is formed. While monitoring reflective light of the helium-neon laser 16 via the photo-detector 7, the substrate 1 is shifted via the X-Y stage 8 to enable the laser condensing point to be oriented to wiring 14, and then, direct drawing of boron-doped silicone is executed. When the condensing point is close to the wiring 14, intensity of reflective light sharply rises, and thus, by replacing the above raw-material gas with the mixed gas composed of oxygen and silane, the replaced gas is blown onto the substrate 1 via the nozzle 10

at the position at which intensity of reflective light sharply rises. Then, while continuously monitoring reflective light, by applying the heated effect of the substrate 1, direct drawing of silicon oxide film is executed. Next, at the moment at which intensity of reflective light has descended to such a degree before approaching the wiring 14, the X-Y stage 8 is shifted in the direction inverse from the last direction, in other words, the stage 8 is shifted in the direction in which the wiring 13 is oriented to the beam-condensing point. Next, at the moment at which intensity of reflective light has risen again as a result of the shift of the condensing point to such a point close to the directly drawn boron-doped silicon, the raw-material gas is again replaced with the mixed gas composed of diborane and silane, and then, direct drawing of boron-doped silicon is executed up to the wiring 15, and finally connects the wiring 13 to the wiring 15 as of the state of insulating the wiring 14.

In the invention, wiring can be corrected by way of insulating only the needed portion by merely executing direct drawing of wiring via laser CVD by properly replacing raw-material gas. Accordingly, correction of wiring has been completed via a single round of process without wholly or locally forming insulation film and also without forming holes in the insulation film.

In the invention, it was found that only less than 0.1

second of time was needed for replacing the raw-material gas, and yet, inasmuch as the shift distance of the stage 8 was quite small against the condensing diameter, wire disconnection was not generated. It was also found that , although two kinds of gas could be mixed together to some extent in the course of replacing them, inasmuch as raw-material gas needed for deposition was supplied by way of blowing it onto the condensing point, influence of dregs generated by the other raw-material gas was such a degree that did not obstruct electric characteristic of the device.

In the embodiment of the invention, the above description has solely referred to the case of forming film by way of decomposing raw-material gas by the heating effect of the substrate caused by irradiation of laser beams. However, it is not always necessary to effect thermal decomposition, but when using such a mixed gas composed of disilane and boron for forming metallic film and also such a mixed gas composed of disilane and oxygen for forming insulation film as the raw-material gas and also ArF laser (193nm) as the light source, it is also possible to implement correction of the wiring by utilizing photochemical decomposition.

Further, the above description of the embodiment of the invention has solely referred to the case in which only a single wiring to be subject to insulation has been disposed between a pair of wiring to be subject to connection. Nevertheless,

even in such a case in which more than two of wiring to be subject to insulation are provided, it is possible to achieve the exactly identical effect of correction.

(Effect of the Invention)

As has been described above, according to the invention, in the course of executing direct-draw CVD process via laser beams, required portion can be insulated by way of replacing raw-material gas, and thus, wiring can be corrected merely by applying the direct-draw CVD process without executing other processes. Further, since only one kind of optical system is needed, dimension of the processing apparatus can be contracted. As has been described above, according to the invention, it is possible to provide such a method of forming film enabling correction of wiring including local insulation via simple processes by applying a compactly simplified apparatus.

4. BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic block diagram designating an apparatus applying the method according to an embodiment of the invention.

Explanation of the Reference Numerals:

1: Substrate

2: CVD chamber

3: Window

4: Lens

5, 17: Beam splitter

6: Argon laser

7: Photo-detector

8: X-Y stage

9, 10: Nozzle

11: Bellow hose

12: Rotary pump

13, 14, 15: Wiring

16: Helium-neon laser

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FIG. 1 (deleted because of the identical reference numerals shown above)